Coronary artery motion analysis in patients with atrial fibrillation using real-time True FISP cine imaging to reduce artifacts in CT and MR coronary angiographies

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BACKGROUND AND PURPOSE

Atrial fibrillation (Af) is the most common type of arrhythmia, and is often associated with coronary artery disease (CAD). Also, patients with Af may present symptoms mimicking CAD. Therefore, noninvasive evaluation of CAD is an important issue in the management of patients with Af. However, fluctuation of coronary artery position beat by beat due to Af can result in image blurring on MR coronary angiography (MRCA) and banding artifact on CT coronary angiography (CTCA). The purpose of this study was evaluating coronary artery motion in patients with Af using real-time True FISP cine MR imaging to determine the most suitable cardiac phase for MRCA and CTCA.

MATERIALS AND METHODS

Twenty-two patients with Af (mean age, 67 ± 12 years; range, 42-92 years; 10 male) were enrolled in the study. The mean heart rate was 63.5 ± 11.0 beats per minute (bpm) (range; 44.0-83.6 bpm) and heart rate variability (the difference between the highest heart rate and the lowest heart rate in each examination) was 45.9 ± 18.8 bpm (range; 12.0-93.3). MR imaging was performed with a 1.5-T imager (Magnetom Sonata, Siemens). A total of 127 sequential transaxial cine images was acquired at the mid ventricular level using a real-time True FISP cine sequence (TR/TE of 2.5 msec / 1.25 msec, FA of 50°, slice thickness 10 mm) with breath-hold. Use of an image data acquisition matrix of 64 x 128 and a field of view of 230 mm resulted in a voxel size of $3.6\times1.8\times10$ mm. View sharing and parallel imaging (using acceleration factor 2) reduced the effective temporal resolution to 55 msec. In the 127 images, 4 to 10 (mean 6.6) R waves were included. The right coronary artery (RCA) was identified on every cine MRI image, and coordinates of the RCA center was measured by placing a marker manually on a workstation. Cardiac phase of each cine image was determined between 440 msec before and 440 msec after the R wave by using electrocardiogram acquired simultaneously with real-time cine image.

As an index of RCA motion, displacement of the RCA parallel to the long axis of the left ventricle was measured relative to the point of the RCA when it was most distant from the apex among the 127 images (maximum dilation) (Figure 1). By using the displacement, influence of the RR interval on the position of the RCA was evaluated. In addition, fluctuation of RCA position at each cardiac phase was defined as distance of RCA position between successive heartbeats.

RESULTS

The fluctuation of RCA position was smallest (1.1 ± 0.5mm) at the enddiastoilc phase (55 msec before the R wave), and larger at systolic and middiastolic phase (Figure 2). The displacement of the RCA was influenced by RR interval. When the RR interval was 700 msec or less, the RCA could not return to the preceding position at the enddiastolic phase (Figure 3).

CONCLUSION

In patients with Af, data acquisition or image reconstruction at enddiastolic phase is best for MRCA and CTCA because fluctuation of coronary artery position is smallest at 55 msec before the R wave. Small fluctuation of coronary position between successive heartbeats is essential to reduce banding artifact in CTCA. However, the RCA may not return to the preceding position at the enddiastolic phase when the RR interval is 700 msec or less. Therefore, cut off of data from heart beats with RR interval < 700 msec will improve image quality.

Figure 1. Displacement of the RCA (Representative case)

Figure2. The fluctuation of RCA position

Figure3. The displacement of the RCA